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SENSITIVITY ANALYSIS OF SERIAL AND PARALLEL MANIPULATOR – A REVIEW

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ABSTRACT

This paper represents the comprehensive synthesis of the latest results on the possible mechanical architecture, on their analysis by using sensitivity indices and possible uses of this analysis for selection of better precise manipulators. In this study, the importance of sensitivity is discussed, as high sensitiveness leads to poor unexpected performance. For better orientation and position of robot end effectors, the sensitivity analysis of the robot is needed, with the proper position of robot can work effectively comparatively less cost.

KEYWORDS: Position, Orientation, Serial and Parallel Manipulator & Sensitivity Analysis

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A Review

INTRODUCTION

In industrial automation the parallel and serial manipulators are considered as the alternative to the conventional manufacturing, to achieve precise positioning, Mass production, high load carrying capacity, high accuracy and better dynamic performance, which leads to higher quality products and economical. However the automation plays a major role in the industries, the process like grinding, drilling, milling, surface grinding, polishing etc require high stiffness, Rigidity, sensitivity, precise positioning and accuracy which are cannot be possible in the serial manipulator because of cantilevered structure, so parallel manipulator is the better alternative for high load carrying capacity

Motivation and Importance of Present Work

Parallel manipulator applications are evident even the serial manipulators have more industrial applications, In this paper, the parallel manipulator sensitivity analyzed to select a better configuration of the serial manipulator in the workspace.

Stephane Caro et al(2009) Conducted kinematic sensitivity analysis of three RPR parallel planar manipulator. The variations within the geometric parameters helped to pick out the best orientation and position of a parallel manipulator. They have calculated the sensitivity coefficients and indices for the manipulator. They formulated a standard procedure to compare different actuation positions in a manipulator. Wang J et al(1993) has calculated the results of various errors on platform accuracy applying forward kinematics approach. That helps to calculate the process of the end effectors based on the calculated limb lengths, base manufacturing and assembly allowances. Whereas inverse kinematics are applied for the upgrading of joint

variables for every link in Stewart Platform.

Han. S. Kim et al. (2000) examined three DOF translational parallel planar manipulator referred to as a Cartesian parallel manipulator. By analyzing 2-actuation ways i.e rotary actuation and linear actuation, they need to found that linear actuation has the advantage on the former methodology of actuation. They applied atechnique to maximize the stiffness throughout the bending position of the manipulator. Fouad Bennis et al. (1996) has laid down the steps to search out a strong manipulator for a given task and calculate its optimum dimensional tolerances. Theyneed to ne elaborated the approach in two steps, initial the size of mechanisms are computed by means that of an acceptable robustness index. Second is computing the best dimensional tolerance of the mechanism by means that of the new tolerance synthesis methodology.

Stephane Caro et al(2007) has demonstrated kinematic sensitivity analysis of parallel manipulators by using sensitivity indices. Two reciprocal methods are used to estimate the kinematic sensitivity indices of a 3-DOF parallel manipulator. They found linkage kinematic sensitivity analysis to have an idea of the influence of link lengths. Differential vector method is used to study the influence of the length and angular variation in the parts of the manipulator on the position and orientation of its end effectors. Alexander Yu et al. (2008) in this paper they have evaluated the accuracy indices of planar parallel robots, which are widely used in industrial applications. The parameters like dexterity, kinematic manipulability, and global conditioning index are applied to translational and rotary motions of parallel robots. They have inherent problems. In this work, they applied a simple method for calculating the correct local maximum position error and the maximum orientation errors.

Meng J zhang et al(2008) work includes a general way to calculate the maximum position problems of parallel and serial manipulators. An error estimation model is formulated. This is applied to the serial and parallel robots. They formulation is like as standard convex optimization problem the global maximal pose error in a prescribed workspace can be computed effectively. Over-constrained and non over obliged parallel manipulators joint displacements are shown in his research. A mathematical example is considered for the performance of these processes.

Ilian A. Bonecv et al. (2003) different kinematic designs of parallel manipulators are studied in this research work. These yields to theoretical information about the parallel kinematics of PPMs. The results obtained by their analysis are used to select the optimal design for a task. They have presented singularity analysis of 3- DOF planar parallel manipulator. Jean Pierre Merlet et al. (2005) estimated Jacobian and inverse Jacobian matrices of parallel manipulators for better pose and orientation of end effectors. A major issue for such use is optimum design as the functioning of parallel robots is very sensitive to their dimensions. Optimal design methodologies always rely on kinetostatic performance indices and accuracy is clear a major issue for many applications in their work they defined dexterity indices of the serial manipulator.

Alba-Gomez et al. (2005) suggested that a characteristic length possible form is achieved in singular configuration when the condition number is equal to one, these results providing a consistent kinetostatic performance index. A second index is defined by a geometric interpretation of the distance to a singularity. The two indices are analyzed and utilized as improvement criteria for the kinematic inversion in the presence of kinematic redundancy. These types of indices are used to the optimum kinematic inversion for a direction characterized in a position. Chablat D et al. (2004) work, on interval examination, based on the technique which is addressed for the design and comparison of 3-DOF PKM. This strategy considers two criteria, (I) a standard regular workspace shape and, (ii) a kinetostatic performance index that

should be as homogeneous as possible throughout the workspace. Two essential tools and an algorithm that considers these two criteria are introduced on the basis of prescribed kinetostatic, performances, the workspace is investigated to discover the biggest regular dexterous workspace was decided for milling application however it can be different for other applications.

Waseem A Khan et al. (2006) studied the forward displacement analysis of Three-class planar manipulator. A new approach for the forward relocation is presented in their work. The forward displacement kinematic analysis of parallel manipulator with non-similar aligned base is reduced to a cubic arrangement. These techniques are utilized to the improvement of a quick moving parallel manipulator. Al Sultan et al(1997) used tabu algorithm to find the global minimum for non-convex function. The algorithm has two features. First, it resembles Hooke's and jeeva's algorithm. Secondly, generates the random search direction and perform line search in every direction.

Jayant K. Mohanta et al. (2018) worked on two different configurations with their fixed base plate Triangular and U-Shaped fixed-base plate sensitivity is analysed and it is suggested that Triangular shaped fixed base configuration has less sensitive for non compensable errors, which cannot be reduced by offline calibration process, but by using Task space motion control technique in trajectory tracking the non compensable errors can be optimized. Hadi Asadi et al.(2017) analysed sensitivity parameters by considering various types of analysis and decided that the parameter weight coefficients are more sensitive than others, they concluded that this parameter is clearly controlled due to its high sensitivity, they also finalized that the length of robot link also effecting the sensitivity, more link length cause more sensitivity.

B. Siciliano et al. (2015) consolidated methodologies and technologies are grouped in the four parts of the second part, covering robot structures, sensing and perception, manipulation and interfaces, mobile and distributed robotics and human-centered and lifelike robotics. Jun Wu et al.(2010) compared the performance of three planar 3-DOF parallel manipulators with 2-RRR, 3-RRR & 4-RRR structures. They generated payload, velocity, stiffness, sensitivity indexes and compared based on these parameters. They concluded that the stiffness of robot depends on various factors which includes material, specifications of the link, type of mechanism and control and actuation system, also they concluded that the payload, conditioning and stiffness performance of 3-DOF,4DOF is showing better results and the 2DOF manipulator is showing one of the worst performance.

Mikhael Tannous et al. (2004) the interval linearization method applied in this work which gives verified final results for the sensitivity analysis of serial and parallel manipulators, since it is based on a rigorous linearity that takes nonlinearities into consideration. This process turns out to give accurate results even when the manipulator under study is close to a singular configuration. It is useful in comparison with the standard linearization method where results are provided even too close to singular configurations but are not reliable. The method proposed in this paper was implemented using the Interval Laboratory Intlab[19] that works with MATLAB. Since the corresponding model is very complex and implements hundreds of trigonometric functions in each of the six equations. We can say that our method is faster than the algorithm presented in [20] since no bisection is needed. As an end conclusion, the proposed process for the kinematic sensitivity analysis of parallel and serial manipulators affords confirmed outcomes and the computation time is acceptable. Later on, the approach will be used to compute the maximum pose errors of serial and parallel manipulators because of joint clearances.

C. Aditya et al. (2018) this paper explains the sensitivity analysis of serial robot, they have calculated the position of serial manipulator and orientation angle. As earlier research confirms that the variations in the geometric parameters as

manufacturing tolerance and installation errors are ignored, the analysis is made for four structures with different link lengths. Suggested that the structure is used the position of work in the working location with the best accuracy. Mohammed Hussein Saadatzi et al(2011) proposed a case study of the 3-RPR planar Mechanism with Geometric Interpretations, concluded that the kinematic sensitivity index is to be considered as global performance index which is used in the optimization of the manipulator. They studied these effects on a Stewart-Gough platform and other development in the robust approach.

CONCLUSIONS

The sensitivity indices have put a noteworthy part to work controller (manipulator) with high performance. A high sensitivity of manipulator parameters leads to poor and unanticipated performance. In parallel and serial manipulators the dissimilarities in the geometric parameters of the parallel manipulator can be magnified. The researcher did a sensitivity analysis for 3RPR parallel manipulator. In the proposed work 4 RPR, or other combinations can be done by taking a square or pentagonal moving plate into consideration, sensitivity analysis can be carried out for 5RPR manipulator. In my future work, I will compare the 3,4 and 5 RPR parallel manipulator performance based on sensitivity indices, as sensitivity is a prime parameter to select parallel manipulator. This work may be extended to actuator position change like form RPR to PRR, PRR etc with these all different analysis the manipulator selection for better performance is simple.

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